FEBRUARY 2012

MARINE MAMMAL AND SEABIRD BYCATCH IN CALIFORNIA GILLNET FISHERIES IN 2010

by

James V. Carretta and Lyle Enriquez

ADMINISTRATIVE REPORT LJ-12-01

Marine mammal and seabird bycatch in California gillnet fisheries in 2010.

James V. Carretta[1] and Lyle Enriquez[2]

[1] Protected Resources Division
Southwest Fisheries Science Center
National Marine Fisheries Service, NOAA
3333 North Torrey Pines Court
La Jolla, CA 92037 USA
Jim.Carretta@noaa.gov

[2] Southwest Regional Office
National Marine Fisheries Service, NOAA
501 West Ocean Boulevard
Long Beach, CA 90802 USA
Lyle.Enriquez@noaa.gov

ABSTRACT

Observed and estimated bycatch of marine mammals and seabirds is reported for the **California swordfish and thresher shark drift gillnet fishery** and the **California halibut and white seabass set gillnet fishery** from fishery observer data collected in 2010. Estimates of bycatch are generated using ratio estimation methods. There was no observed bycatch of sea turtles in California fisheries in 2010.

Observations in the swordfish and thresher shark fishery include 59 sets during 12 fishing trips, from an estimated 492 sets fished by all vessels (11.9% observer coverage). Observed bycatch included three short-beaked common dolphin (*Delphinus delphis*), one long-beaked common dolphin (*Delphinus capensis*), one northern right whale dolphin (*Lissodelphis borealis*), one common bottlenose dolphin (*Tursiops truncatus*) and two sperm whales (*Physeter macrocephalus*). All marine mammals were dead upon retrieval, with the exception of one sperm whale that was released seriously injured with trailing gear. Estimated bycatch is 25 (CV=0.64) short-beaked common dolphins, 8 (CV=1.00) long-beaked common dolphins, 8 (CV=0.98) northern right whale dolphins, 8 (CV=0.96) bottlenose dolphins, and 16 (CV=0.95) sperm whales.

Observations in the halibut and white seabass fishery include 216 sets during 57 fishing trips, from an estimated 1,724 sets fished by all vessels (12.5% observer coverage). Observed bycatch included one long-beaked common dolphin (*Delphinus capensis*), 25 California sea lions (*Zalophus californianus*), three harbor seals (*Phoca vitulina*), two common murres (*Uria aalge*), one double-crested cormorant (*Phalacrocorax auritus*), one Brandt's cormorant (*Phalacrocorax penicillatus*), one unidentified gull (family *Laridae*) and three unidentified birds. Estimated bycatch is 7 (CV=1.07) long-beaked common dolphin, 199 (CV=0.30) California sea lions, 23 (CV=0.59) harbor seals, 15 (CV=1.05) common murres, 7 (CV=1.15) double-crested cormorants, 7 (CV=1.13) Brandt's cormorants, 7 (CV=1.00) unidentified gulls, and 23 (CV=1.03) unidentified birds.

Other fisheries observed in 2010 include the **CA yellowtail, barracuda, and white seabass drift gillnet fishery** (11 sets, approximately 5% observer coverage) and the **CA pelagic longline**

fishery (at 100% observer coverage) that operates outside of the U.S. Exclusive Economic Zone. There was no marine mammal, sea turtle, or seabird bycatch observed in either fishery in 2010. Data confidentiality regulations preclude the reporting of set data for the California pelagic longline fishery, as only one vessel was active.

INTRODUCTION

Background

NOAA's National Marine Fisheries Service (NMFS) is required under Section 118 of the Marine Mammal Protection Act (MMPA) to "*obtain statistically reliable estimates of incidental mortality and serious injury*" of marine mammals in commercial fisheries, also known as 'bycatch'. Estimates of bycatch are used in the preparation of marine mammal stock assessments as required under Section 117 of the MMPA, with particular emphasis on how bycatch levels compare with potential biological removal (PBR) levels of a given marine mammal stock. The PBR level is defined as the maximum number of animals (not including natural mortality) that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. In addition to marine mammals, NMFS also estimates bycatch of other taxa, including sea turtles, fish, sharks, and seabirds. This report includes observed and estimated bycatch of marine mammals and seabirds from fishery observations in California commercial fisheries in calendar year 2010. Estimates of shark, finfish, and invertebrate bycatch in California commercial fisheries has been reported elsewhere (Larese and Coan 2008). No turtle bycatch was observed in 2010.

Fishery Classification Criteria

NMFS is required under Section 118 of the Marine Mammal Protection Act (MMPA) to place all U.S. commercial fisheries into one of three categories based on levels of incidental serious injury and mortality of marine mammals in each fishery (16 U.S.C. 1387 (c) (1)). Each year, NMFS publishes a 'List of Fisheries' in the Federal Register that determines whether fishery participants are subject to registration, observer coverage, and take reduction plan requirements. Fisheries are classified as Category I, II, or III, depending on the level of incidental takes relative to the PBR for each marine mammal stock. Category I fisheries are defined as those for which the annual level of incidental take of one or more stocks is greater than or equal to 50% of a stock's PBR. Category II fisheries are defined as those for which the annual takes of one or more stocks are greater than 1% but less than 50% of PBR. Category III fisheries include those where the overall serious injury and incidental take of all marine mammal stocks, across all fisheries that interact with these stocks, is less than 10% of the stocks' PBR level. In cases where combined takes across all fisheries exceed 10% for one or more stocks, then only those fisheries with annual takes less than 1% of PBR are considered Category III.

Fishery Descriptions

The **California swordfish and thresher shark large-mesh drift gillnet fishery** is a Category II fishery (Federal Register 76 FR 37716, 28 June 2011) with approximately 25 vessels participating. This fishery has been observed by NMFS annually since 1990, with annual observer coverage levels ranging between 4% and 20%. Historically, a wide variety of cetacean, pinniped, sea turtle, and seabird species have been incidentally caught in this fishery (Julian and Beeson, 1998;

Barlow and Cameron 2003; Carretta *et al*., 2004, Carretta *et al*. 2008, Carretta and Barlow 2011). A Take Reduction Plan (TRP) was implemented in 1996 because bycatch levels exceeded PBR for some cetacean stocks. The TRP resulted in the mandatory use of acoustic pingers on all nets, net extenders to increase minimum fishing depth to 11 m (6 fm), and mandatory skipper education workshops. Although marine mammal bycatch was significantly reduced as a result of pinger use in this fishery (Barlow and Cameron 2003), continued bycatch of leatherback turtles resulted in the establishment of a seasonal (15 August – 15 November) area closure in central California and southern Oregon waters in 2001 (Figure 1). An additional season/area closure in southern California is implemented during forecasted or existing El Niño periods to reduce the likelihood of entangling loggerhead turtles.

The **California halibut and white sea bass set gillnet fishery** is a Category II fishery (Federal Register 76 FR 37716, 28 June 2011) with approximately 50 vessels participating. This fishery currently operates only south of Point Conception, California. The fishery has been observed sporadically in recent years, with observer coverage levels of less than 10%.

The **California yellowtail, barracuda, and white seabass drift gillnet fishery** is a Category II fishery (Federal Register 76 FR 37716, 28 June 2011) with approximately 30 vessels participating. This fishery operates in southern California offshore waters near the Channel Islands. The fishery has been observed sporadically in recent years, with observer coverage levels of less than 10%.

Basic fishery descriptions can be found in marine mammal stock assessments published annually by NMFS (Carretta *et al*. 2011) and in the NMFS 2011 List of Fisheries (Federal Register 76 FR 37716, 28 June 2011)

METHODS

Estimation of Fishing Effort and Observer Coverage

Total fishing effort in the swordfish and thresher shark drift gillnet fishery is estimated from vessel operators' reports to the NMFS observer contractor. In addition, logbook data from the California Department of Fish and Game are utilized to estimate effort. Annual effort estimates from each source are usually similar, but the larger value is used for the purpose of bycatch estimation. In the swordfish and thresher shark drift gillnet fishery, one set is equal to one day of fishing effort, as nets are deployed near sunset and retrieved the next morning. Observer coverage is estimated as the number of observed sets, divided by the number of estimated sets fished.

Fishing effort in the halibut and white seabass set gillnet fishery is estimated from logbook data. Multiple sets per day are fished in the set gillnet fishery. Observer coverage is calculated as the number of observed fishing sets, divided by the estimated number of sets fished from logbook data. The most recent year for which complete logbook data are available is 2009, when 1,724 sets were reported fished. This value is used in place of pending logbook data for 2010.

Fishing effort in the yellowtail, barracuda, and white seabass drift gillnet fishery is estimated from logbook records. The most recent year for which complete logbook data are available in 2009, when 235 sets were reported fished. Observer coverage is calculated in the same manner as for the set gillnet fishery.

Bycatch Estimation

Bycatch is estimated with a ratio estimator following methods used by Julian and Beeson (1998) and Carretta *et al*. (2004). The bycatch rate for each species is calculated as

$$\hat{r}_s = \frac{\sum b_s}{\sum d} \qquad (1)$$

where b_s is the observed bycatch (in individuals) of species *s* during a fishing trip and *d* is the number of days (or sets) observed during the trip. The variance of the bycatch rate ($\sigma^2_{\hat{r}_s}$), is estimated with a bootstrap procedure, where one trip represents the sampling unit. Trips are resampled with replacement until each bootstrap sample contains the same number of trips as the actual observed effort. This method is preferable to resampling sets, because sets within a trip are more likely to be spatially and temporally correlated. A bycatch rate is then calculated from each bootstrap sample. This procedure is repeated 1,000 times, from which the bootstrap or bycatch rate sample variance $\sigma^2_{\hat{r}_s}$, is calculated.

Annual bycatch estimates ($\hat{m}_s$) for species *s* and the variance of the bycatch estimate (σ^2_m) are estimated for each species using the following formulae:

$$\hat{m}_s = \hat{D}\ \hat{r}_{s,} \qquad (2)$$

$$\sigma^2_m = \hat{D}^2\ \sigma^2_r \qquad (3)$$

where

$\hat{D}$ is the estimated number of sets fished,
$\hat{r}_s$ is the kill rate per set for species *s* and
σ^2_r is the bootstrap estimate of the kill rate variance.

RESULTS

Swordfish and thresher shark drift gillnet

In 2010, 59 sets were observed during 12 vessel trips, from an estimated 492 sets fished, resulting in an observer coverage rate of 11.9% (Table 1, Figure 1). Fishing effort in 2010 was determined exclusively through vessel activity reports submitted to the observer contractor, because complete logbook data were unavailable at the time this report was prepared. In 2010, 25 vessels made at least one set, though only 11 were observed. Eight vessels were deemed 'unobservable', because they are smaller vessels that lack berthing space for observers. Observer program tracking of sea days indicates that the 8 unobservable vessels contributed approximately 40-45% of the total fishing effort in 2010 (Scott Casey, Frank Orth & Associates, personal communication). An additional six vessels were not observed in 2010 due to unavailability of observers at the time these vessels fished. Fishing effort has declined from over 5,500 sets in 1993 to 492 sets in 2010 (Figure 2). In 2010, observed bycatch totals included three short-beaked common dolphin (*Delphinus delphis*), one long-beaked common dolphin (*Delphinus capensis*), one northern right whale dolphin (*Lissodelphis borealis*), one common bottlenose dolphin (*Tursiops truncatus*) and two sperm whales (*Physeter macrocephalus*). Both sperm whales were entangled in the same net. All marine mammals were dead upon retrieval, except one sperm whale released with trailing gear that was considered seriously injured (Table 1). Estimated bycatch is 25 (CV=0.64) short-beaked common

dolphins, 8 (CV=1.00) long-beaked common dolphins, 8 (CV=0.98) northern right whale dolphins, 8 (CV=0.96) common bottlenose dolphins, and 16 (CV=0.95) sperm whales (Table 2).

Sperm whale entanglements in the swordfish and thresher shark drift gillnet fishery have been rare, with only 10 records in over 8,000 observed fishing sets since 1990. Since acoustic pingers were introduced into the fishery in 1996, 4 sperm whale entanglements have been recorded. The entanglement of two sperm whales in 2010 occurred during the fifth set of a trip where all 40 pingers were found to be functional during observer checks of the first set. Following the entanglements, observers confirmed that pingers adjacent to the entangled animals were functioning. Observer notes indicated that a dead sperm whale approximately 20 ft. in length was cut loose from the net and that no photos of this animal were taken. Photographs of the released whale show an animal on its side with its head underwater. Based on the attitude of this animal, the fact that it was released with netting, and the fact that the associated animal had died, we have determined that the injuries incurred by the released animal were likely to result in death. Thus, the released animal is considered 'seriously injured'.

Halibut and white seabass set gillnet

In the halibut and white seabass set gillnet fishery, 216 sets during 57 fishing trips were observed from an estimated 1,724 sets fished by all vessels (12.5% observer coverage) (Figure 6). Observed bycatch included one long-beaked common dolphin (*Delphinus capensis*), 25 California sea lions (*Zalophus californianus*), three harbor seals (*Phoca vitulina*), two common murres (*Uria aalge*), one double-crested cormorant (*Phalacrocorax auritus*), one Brandt's cormorant (*Phalacrocorax penicillatus*), one unidentified gull (family *Laridae*) and three unidentified birds. Estimated bycatch is 7 (CV=1.07) long-beaked common dolphin, 199 (CV=0.30) California sea lions, 23 (CV=0.59) harbor seals, 15 (CV=1.05) common murres, 7 (CV=1.15) double-crested cormorants, 7 (CV=1.13) Brandt's cormorants, 7 (CV=1.00) unidentified gulls, and 23 (CV=1.03) unidentified birds.

Yellowtail, barracuda, and white seabass drift gillnet

A total of 11 sets were observed from an estimated 235 sets fished by all vessels (4.6% observer coverage). No bycatch of marine mammals or seabirds was observed.

DISCUSSION

Since acoustic pingers were introduced into the swordfish and thresher shark drift gillnet fishery in 1996, overall cetacean entanglement rates have declined by approximately 50% and there have been no observations of beaked whale bycatch during this time (Barlow and Cameron 2003, Carretta *et al*. 2008, Carretta and Barlow 2011, Figure 3). Short-beaked common dolphins continue to be the most commonly entangled species in this fishery. However, entanglement rates of common dolphin are approximately 50% lower since the introduction of acoustic pingers (Figure 4), despite the fact that the fishery today operates almost exclusively south of Point Conception, where common dolphin abundance is highest (Barlow and Forney 2007).

Barlow and Cameron (2003) reported a statistically significant *decline* in sea lion entanglement rates in drift gillnets with pingers during a 1996-1997 experiment, though this decline was somewhat unexpected, because it was thought that pinnipeds might be attracted to pingered nets to feed on the captured fish (the "dinner bell" effect). Following the pinger experiment, entanglement rates of sea lions *increased*, compared to sets without pingers (Carretta and Barlow

2011). However, an analysis of depredation of swordfish catch by sea lions in the drift gillnet fishery found that pinger use was no better a predictor of depredation than a random variable (Carretta and Barlow 2011). The number of pingers used was found to be 16th in importance out of 20 variables tested, while the variables total swordfish catch, month fished, area fished, and nocturnal use of vessels' deck lights provided the most predictive power of depredation (Carretta and Barlow 2011). Some of the increase in sea lion entanglement rates in recent years likely reflects the continuing increase in sea lion numbers in the area where the fishery occurs (Carretta and Barlow 2011).

The fraction swordfish and thresher shark drift gillnet effort in 2010 that involved 'unobservable' or 'unobserved' vessels was approximately 40-45% of the total estimated effort, which raises concerns about the randomness of the observer sample. An underlying assumption of ratio estimation is that unobserved and observed fishing effort is 'equivalent'. This assumption requires that unobserved vessels are compliant with pinger, extender length, closure area, and other gear regulations, and that bycatch rates are no different from observed vessels. If bycatch rates on unobserved vessels are significantly different, this would bias the resulting bycatch estimates. Vessels in this fishery are periodically boarded and inspected for gear compliance, and recorded violations have been rare (NMFS Enforcement, personal communication). A video experiment was utilized in the drift gillnet fishery recently to see if video monitoring of bycatch would be feasible on unobservable vessels. Some shortcomings of that methodology were identified, such as the inability to identify bycatch to species, high cost, and battery power drain issues for the fishing vessels. The Pacific Offshore Take Reduction Team recommended in 2007 that NMFS continue to pursue other technologies to address this gap in observer coverage, while continuing to refine the video technology for potential future use on unobservable vessels.

ACKNOWLEDGMENTS

Thanks to Suzy Kohin for maintaining the fishery observer database. Amy Betcher, Scott Casey, and John Childers provided logbook and observer data used to estimate fishing effort. Kerri Danil provided photographic and genetic information on the bycatch specimens. This work could not have been done without the diligent work of NMFS fishery observers and the cooperation of the California commercial fishermen. A draft of this manuscript was reviewed by Jay Barlow, Susan Chivers, and the Pacific Scientific Review Group at their 2011 annual meeting.

LITERATURE CITED

Barlow, J. and Cameron, G.A. 2003. Field experiments show that acoustic pingers reduce marine mammal bycatch in the California drift gillnet fishery. Marine Mammal Science 19(2):265-283.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105(4):509-526.

Carretta, J.V., T. Price, D. Petersen, and R. Read. 2004. Estimates of Marine Mammal, Sea Turtle, and Seabird Mortality in the California Drift Gillnet Fishery for Swordfish and Thresher Shark, 1996-2002. Mar. Fish. Rev. 66 (2): 21-30.

Carretta, J.V., J. Barlow, and L. Enriquez. 2008. Acoustic pingers eliminate beaked whale bycatch in a gillnet fishery. Marine Mammal Science 24(4):956-961.

Carretta, J.V. and J. Barlow. 2011. Long-term effectiveness, failure rates, and "dinner bell" properties of acoustic pingers in a gillnet fishery. Marine Technology Society Journal 45(5):7-19.

Carretta, J.V., K.A. Forney, E. Oleson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R.L. Brownell Jr., J. Robbins, D.K. Mattila, K. Ralls, and

M.C. Hill. In review. Draft U.S. Pacific Marine Mammal Stock Assessments: 2011. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-xxx.

Carretta, J.V., K.A. Forney, E. Oleson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R.L. Brownell Jr., J. Robbins, D.K. Mattila, K. Ralls, and M.C. Hill. 2011. U.S. Pacific Marine Mammal Stock Assessments: 2010. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-476. 352 p.

Forney, K.A., S.R. Benson, and G.A. Cameron. 2001. Central California gillnet effort and bycatch of sensitive species, 1990-1998. Proceedings – Seabird Bycatch: Trends, Roadblocks, and Solutions. University of Alaska Seagrant. AK-SG-01-01. pp. 141-159.

Julian, F. and Beeson, M. 1998. Estimates of marine mammal, turtle, and seabird mortality for two California gillnet fisheries: 1990-1995. U.S. Fish. Bull. 96:271-284.

Larese, J.P. and A.L. Coan. 2008. Fish and invertebrate bycatch estimates for the California drift gillnet fishery targeting swordfish and thresher shark, 1990-2006. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-426. 53 p.

Table 1. Fishery observer and fishing effort summaries for calendar year 2010 for California gillnet fisheries.

Fishery	MMAP Category	Number of active vessels	Mean mesh size (inches)	Estimated Sets Fished	Observed Sets	Observer Coverage	Observed Species Interactions (number killed or injured)
CA swordfish and thresher shark drift gillnet	Category II	25	20.5	492	59	11.9%	Common dolphin, short-beaked (3) Common dolphin, long-beaked (1) Northern right whale dolphin (1) Bottlenose dolphin (1) Sperm whale (2)
CA halibut and white seabass set gillnet	Category II	50	7.2	1,724*	216	12.5%	Common dolphin, long-beaked (1) California sea lion (25) Harbor seal (3) Brandt's cormorant (1) Double-crested cormorant (1) Common murre (2) Unidentified gull (1) Unidentified birds (3)
CA yellowtail, barracuda, and white seabass drift gillnet	Category II	30	6.5	235*	11	4.6%	None observed

*****Estimated fishing effort is based on logbook data from calendar year 2009, the most recent year for which logbooks are available.

Table 2. Summary of observed bycatch, rates, estimates and statistical precision for the California swordfish drift gillnet fishery in 2010.

Fishery and Species	Observed Bycatch	Bycatch per 100 sets	Bycatch per Set Variance	Bycatch Estimate	Bycatch Estimate CV
CA drift gillnet for swordfish and thresher shark					
Short-beaked common dolphin	3	5	1.0×10^{-3}	25	0.64
Long-beaked common dolphin	1	1.7	2.6×10^{-4}	8	1.00
Northern right whale dolphin	1	1.7	2.4×10^{-4}	8	0.98
Bottlenose dolphin	1	1.7	2.4×10^{-4}	8	0.96
Sperm whale	2	3.3	9.6×10^{-4}	16	0.95

Table 3. Summary of observed bycatch, rates, estimates and statistical precision for the California halibut and white seabass set gillnet fishery in 2010. A total of 216 fishing sets were observed in 2010.

Fishery and Species	Observed Bycatch	Bycatch per 100 sets	Bycatch per Set Variance	Bycatch Estimate	Bycatch Estimate CV
CA set gillnet for halibut and white seabass					
Long-beaked common dolphin	1	0.462	2.3×10^{-5}	7	1.17
California sea lion	25	11.6	1.2×10^{-3}	199	0.30
Harbor seal	3	1.39	6.1×10^{-5}	23	0.59
Brandt's cormorant	1	0.462	2.1×10^{-5}	7	1.13
Double-crested cormorant	1	0.462	2.2×10^{-5}	7	1.15
Common Murre	2	0.925	8.4×10^{-5}	15	1.05
Unidentified gull	1	0.462	2.1×10^{-5}	7	1.00
Unidentified bird	3	1.39	1.9×10^{-4}	23	1.03

Figure 1. Locations of 59 observed fishing sets and marine mammal entanglements in the drift gillnet fishery for swordfish and thresher shark in 2010. Key: ● = set locations; ▲= sperm whale; ▼= long-beaked common dolphin; + = short-beaked common dolphin; ✸ = northern right whale dolphin; □ = bottlenose dolphin. The shaded region indicates a seasonal area closure where drift gillnet fishing is annually prohibited between 15 August and 15 November. Dashed line delineates the U.S. Exclusive Economic Zone.

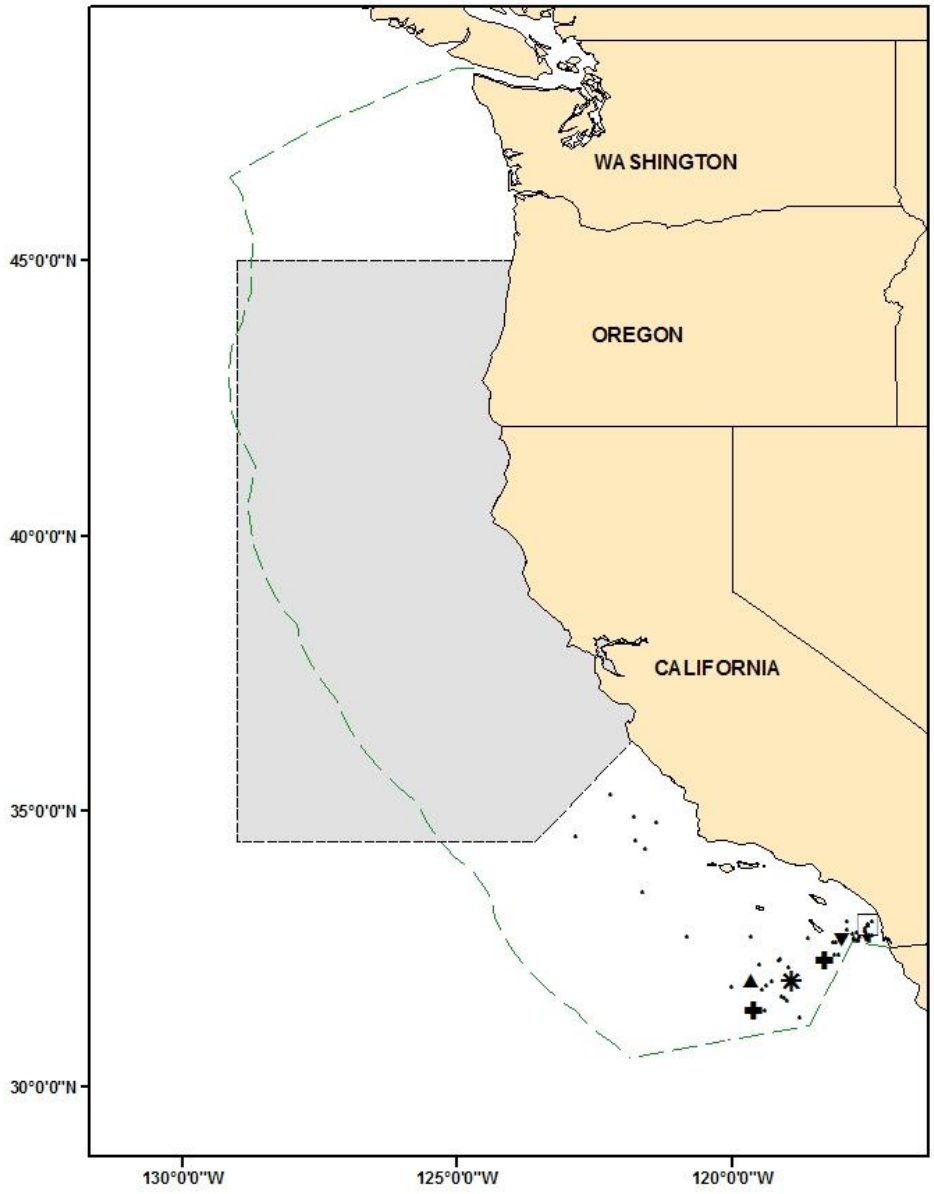

Figure 2. Estimated (gray) and observed (black) days of fishing effort in the California thresher shark and swordfish drift gillnet fishery for 1990-2010. Observer coverage (number of sets observed / number of sets fished) ranged from a low of 4% in 1990 to 22.9% in 2000. Estimated observer coverage in 2010 was 11.9%.

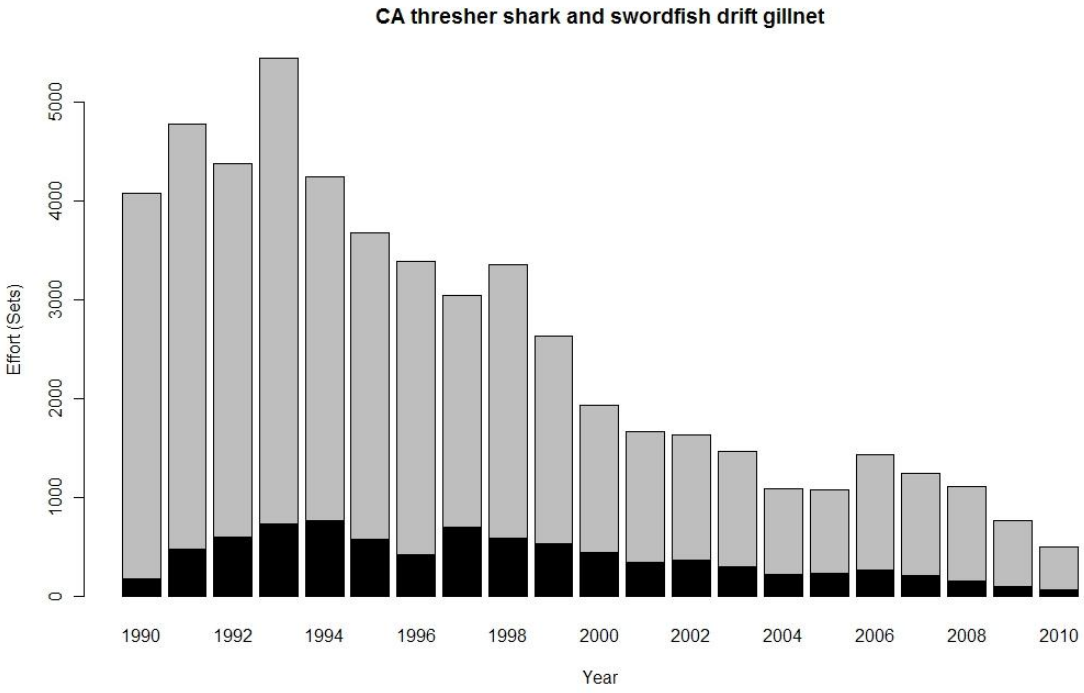

Figure 3. Bycatch rates (individuals per 100 sets) of cetaceans in the California thresher shark and swordfish drift gillnet fishery, 1990–2010.

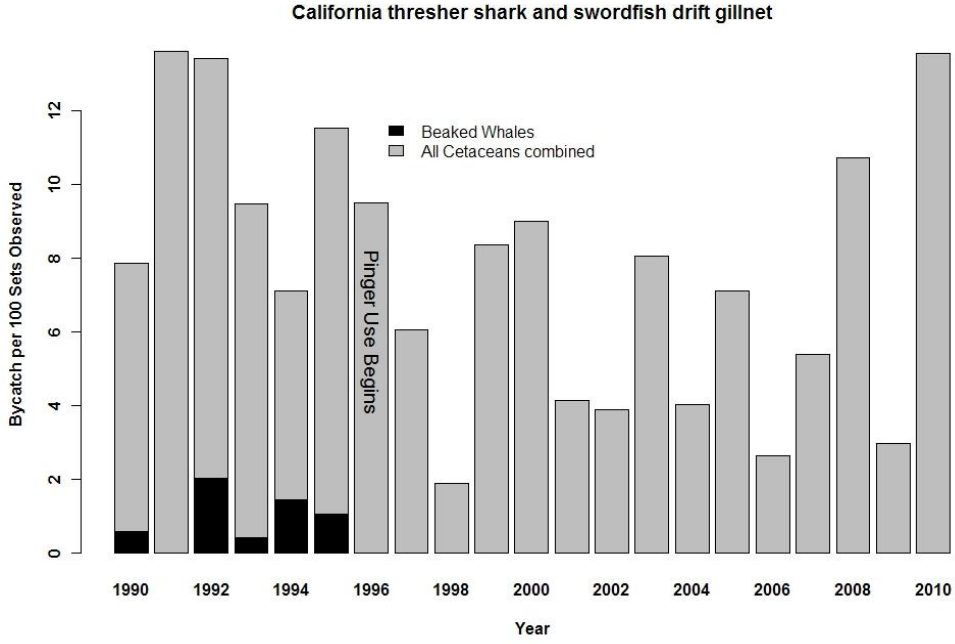

Figure 4. Entanglement rates of short-beaked common dolphin per 100 sets fished in the California swordfish drift gillnet fishery, 1990-2010. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. In 1996, no short-beaked common dolphins were observed killed in 146 pingered sets. For the period 1998-2010, over 99% of all observed sets utilized pingers.

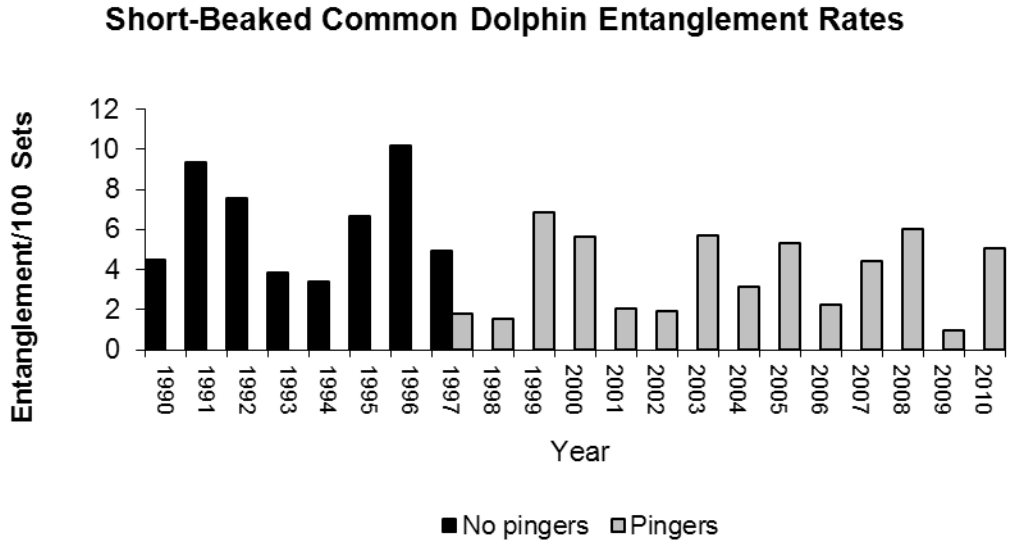

Figure 5. Entanglement rates of California sea lions per 100 sets fished in the California drift gillnet fishery for swordfish and thresher shark, 1990-2010. Pingers were not used from 1990-95 and were used experimentally in 1996 and 1997. For the period 1998-2010, over 99% of all observed sets utilized pingers. No sea lion entanglements were observed in 59 observed sets in 2010.

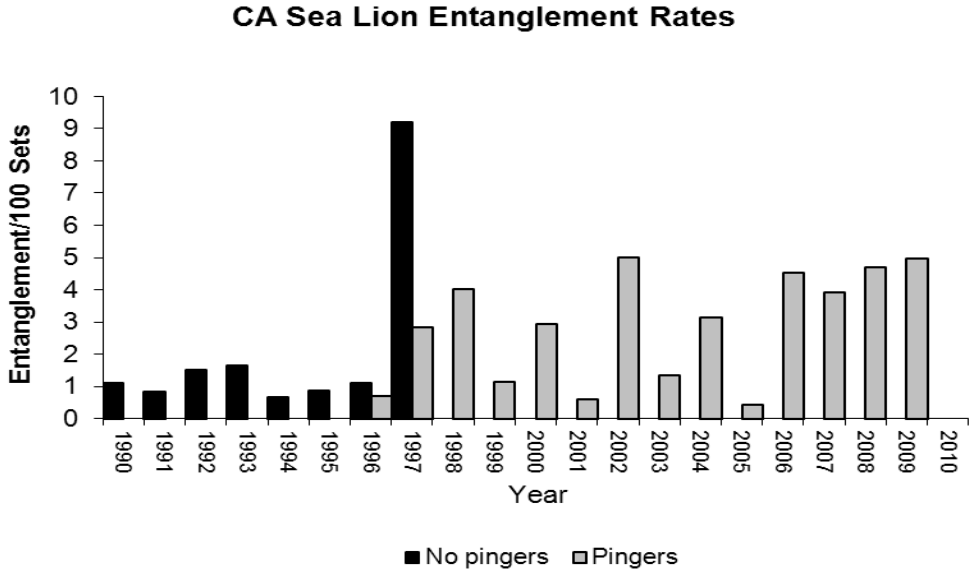

Figure 6. Locations of 216 observed sets (A) and marine mammal bycatch (B) in the halibut and white seabass set gillnet fishery in 2010. Key: ●= California sea lion; ▲= Harbor seal; ■= long-beaked common dolphin.